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Original Research Article

Incidence and risk factors of adjacent segment disease following short segment posterior instrumentation in Bahraini patients: a five-year retrospective analysis

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ABSTRACT

Background: Despite advances in spinal surgery, adjacent segment disease (ASD) and adjacent disc degeneration (ADD) remain notable postoperative complications following spinal fusion, mainly due to suspected increased biomechanical stress that leads to adjacent disc degeneration. This research focuses on the Bahraini population, utilizing MRI to compare pre-op and post-op Adjacent disc conditions to identify the incidence and risk factors of ASD and ADD after short segment spinal fusion.
Methods: A retrospective cohort study conducted over a five-year period at Salmaniya Medical Complex, the largest tertiary care center in the Kingdom of Bahrain. Reviewing pre-operative and post-operative MRI scans of 41 symptomatic patients who underwent short segment spinal fusion between 2014 and 2019. Patients were selected based on specific pre-operative and post-operative criteria developed by the orthopaedic team and were followed up to October 2023. Statistical analyses were performed using R software.
Results: The analysis of 41 patients revealed a significant incidence of adjacent segment changes and the main risk factor that showed significance was advancing age. While other reported risk factors like level of fusion and number of fused segments did not significantly correlate with advancing ADD or ASD. There was no statistically significant association between hypertension, diabetes or multiple comorbidities and worsening conditions for either ASD or ADD post operation.
Conclusions: The findings from our study contribute to the understanding of ASD and ADD after lumbar fusion surgeries, particularly in highlighting the significance of age. These insights can aid surgeons in better anticipating the risks associated with specific demographic and clinical profiles. More controlled studies on larger populations will help delineate more concrete risk factors.

Keywords: Adjacent segment disease, Adjacent disc degeneration, MRI, Risk factors, Short segment spinal fusion

INTRODUCTION

Despite advances in spinal surgery, adjacent segment disease (ASD) and adjacent disc degeneration (ADD) remain notable postoperative complications following spinal fusion, mainly due to suspected increased biomechanical stress that leads to adjacent disc degeneration.[1] Short segment posterior instrumentation is currently one the main treatment options for symptomatic degenerative disc disease, it is also the main method of

spinal fusion done in our Bahraini population. Many studies have evaluated different spine decompression and fixation methods and found that they lead to an increased incidence of adjacent disc degenerative changes and disease. Incidence of adjacent disc disease was reported around 2.62% after 1 year post lumbar or lumbosacral fusion surgery.[2]

MRI is the recognized gold standard for diagnosing spine related pathology, specifically for lumbar degenerative disc disease, it also has recognized imaging classifications and findings to help categorize the severity of the disease.[3]

This research focuses on the Bahraini population, utilizing MRI to compare pre-op and post-op Adjacent disc conditions to identify the incidence and risk factors of Adjacent Segment Disease and Adjacent Disc disease after posterior short segment spinal fusion based on the various reported risk factors noted in other studies like the levels of fusion, the number of fused spinal levels and levels of decompression and laminectomy.[4] And we are also going to examine whether patients' medical chronic illnesses correlate with the development of post-op degenerative disc disease.

METHODS

Study place

The study is a retrospective study conducted in Salmaniya Medical Complex, the largest tertiary center in the Kingdom of Bahrain.

The study followed patients that underwent short segment spinal fusion surgery for degenerative disc disease from 2014 to 2019 and clinically and radiologically assessed the impact of the surgery on the development of adjacent disc pathology. Adjacent segment disease categorized into worsening disc bulge or protrusion or extrusion while adjacent disc degeneration was classified via Pfirrmanns classification using magnetic resonance imaging (MRI) in correlation with patients' clinical assessment.[3,5] MRIs and clinical assessments were done pre-operatively and post-operatively to compare pre-existing adjacent disc condition and post op findings for all involved subjects in the study. A total of 41 patients were included in the study after extensive exclusion criteria.

Patients were operated on by the same Orthopedic spine consultant, the same surgical team and images were interpreted by a consultant musculoskeletal radiologist.

The population was based on a specific pre- operative criterion, created by the orthopedic surgery team to ensure that surgery was necessary. Patients had to have undergone a minimum of six months of physiotherapy without any benefit to their symptoms. They were also required to have taken multiple analgesics without achieving relief from low back pain or sciatica. Furthermore, if patients had received epidural or facet joint injections without improvement, progressive worsening of pain, sciatica and stiffness, along with a notable impact on the patient's quality of life, were all indications for surgery.

The operations were performed over a 5 years period, from 2014 until 2019. However, patients' follow up period was until October 2023. Patients were surveyed pre and post operatively as well using a unique questionnaire, created by the orthopedic surgeons' team, to evaluate risk factors and facilitate risk stratification (Table 1).

The imaging modality of choice was MRI of the spinal cord which was reviewed before and after the surgery. The paper followed a unique protocol of the following sequences: sagittal T1, sagittal T2, sagittal STIR, coronal T2 and axial T2 to assess specific disc degenerative findings. Radiological findings included discs' degeneration, bulge, herniation, annular tears, spondylolisthesis, with the extent of disease evaluated as well. Special algorithms and grading systems, created by Pfirmann et al and others, were followed carefully and reviewed by the same consultant musculoskeletal radiologist.[2]

A unique population in this paper required a repeat MRI post operatively, which prompted the creation of an additional separate criterion. Patients were recommended if they experienced chronic post-operative low back pain that did not improve with conservative measures. Additionally, the development of numbness of unilateral or bilateral lower limbs, reduced mobility or increasing stiffness. Sudden acute low back pain, trauma and symptoms such as urine or stool incontinence were also criteria. Furthermore, MRI was indicated if there was suspicion of cauda equina syndrome or a sudden worsening of any of the symptoms mentioned above.

Using the surgical electronic database in Salmaniya Medical Complex, every patient that underwent spine surgery was retrieved. A total of 207 medical records were determined and collected. The study's initial count was made up of a total of 207 patients, who underwent spine surgery during a 5 years period, from 2014 until 2019. This sample was further modified and categorized using unique inclusion and exclusion criteria. After careful consideration and review of the criteria, the final population count was determined to be 41 subjects.

The inclusion criteria involved patients who underwent short-segment posterior instrumentation with fusion by pedicle screws and rods (rigid fixation), with fewer than six segments involved. Additionally, patients complaining of degenerative disc disease, as determined by pre-operative criteria and MRI scans were required to have been done less than two years before the operation, with a minimum of six months of post-operative MRI imaging as per the post-operative criteria outlined in the study.

The exclusion criteria involved patients who underwent long-segment posterior instrumentation with six or more

segments and those who had other spinal fusion procedures, such as ALIF, XLIF and TLIF. Further exclusion was applied to individuals who had previous spine surgeries, infection or tumor findings on MRI, evidence of fractures in operated segments or inflammatory diseases like rheumatoid arthritis. Patients without MRI follow-up, lost follow-up or those whose MRI had artifacts or did not cover the designated spinal area were also excluded.

The initial count of patients was 207 who underwent posterior instrumentation and fusion for degenerative disc pathology, 132 subjects were excluded from the paper as they did not fit the post operative MRI criterion, mainly due to them not having any further complaints post operatively during follow up appointments, hence a total of 75 subjects remained. The number of patients lost to follow up was 20 due to not attending clinic, deceased or unknown reasons. Patient were further excluded due to evidence of infection, tumors and artifacts on MRI which were 7, 3 and 4, respectively. This resulted in the final population included in this paper to be 41 patients.

The statistical analyses were conducted using R software for statistical computing version 4.1.[6] The chosen significance level was established at 5%, as it denoted the threshold for determining statistical significance. Categorical variables were expressed as frequency and percentages. An analysis was performed to compare categorical variables across two groups, using chi square analysis and Fisher's exact test. A value $p<0.05$ was considered statistically significant.

When the qualitative variables were calculated using chi-square more than 20% of expected values were less than 5, Fisher's exact test was used where feasible, the significance value was not included where chi square was not feasible to avoid multiple assumptions.

Ethical considerations

Our study took place according to the Declaration of Helsinki (as revised in 2013). All data was collected using the surgical electronic database in Salmaniya Medical Complex (I-SEHA) or by physical medical records for patients who underwent surgery before the use of electronic records.

And the paper was reviewed by the tertiary centers' ethical research committee and ethical approval was given to research project.

RESULTS

Demographic data

The study included 41 consecutive patients undergoing spinal surgery, with a slight predominance of females (61%, n=25) compared to males (39%, n=16). Patients' ages were distributed as follows: 17% were under 50 years, 37% between 50 and 60 years and 46% were over 60 years. The most common levels of spinal segments fused were three (44%, n=18), followed by one segment (29%, n=12) and two segments (24%, n=10), with a minority having four segments fused (2%, n=1).

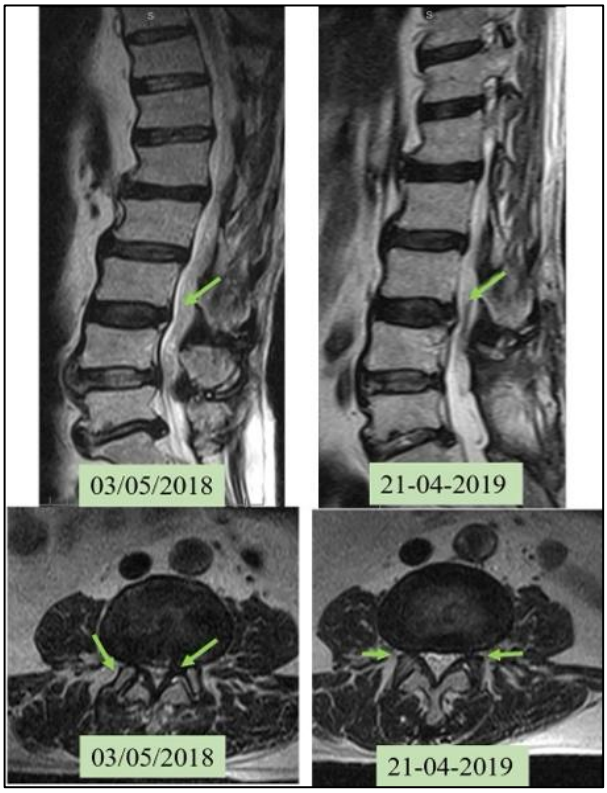

Figure 1: Pre-op and post-op MRI images of a 85 years old male, underwent posterior instrumentation of L4-L5. Images: Sagittal T2 and axial T2 images of the lumbar spine, showing interval development of diffuse disc bulge at L3-L4, with obliterating of lateral recesses, and along with interval worsening of ligamentum flavum thickening resulting in mild to moderate central canal stenosis and bilateral mild neural foraminal narrowing, on the post-operative images (2019).

Regarding the levels of fusion, L2-L5 was the most common (32%), followed by equal frequencies for L3-L5, L4-L5 (both 15%) and L3-S1 (12%). Laminectomies most frequently involved three levels (44%, n=18), followed closely by one level (37%, n=15). The majority of patients did not undergo discectomy (93%, n=38).

In terms of comorbidities, 59% of the patients had diabetes mellitus (DM), 66% had hypertension (HTN) and 59% had more than two comorbidities. Scoliosis was present in 17% of the cases and spondylolisthesis was observed in 20% of the patients.

The incidence of adjacent segment disease (ASD) and adjacent disc degeneration (ADD) are both summarized in (Table 3) in both cranial and caudal directions post short

segment posterior instrumentation for degenerative disc pathology. For ASD, a slightly higher incidence is seen caudally with 54% of the cases compared to 46% cranially. In contrast, ADD is more commonly observed cranially, affecting 60% of the patients, while the caudal direction is less affected, with an incidence of 40%. This indicates a divergent pattern of postoperative degeneration in the spinal segments adjacent to the site of fusion, with a noticeable propensity for cranial ADD and caudal ASD.

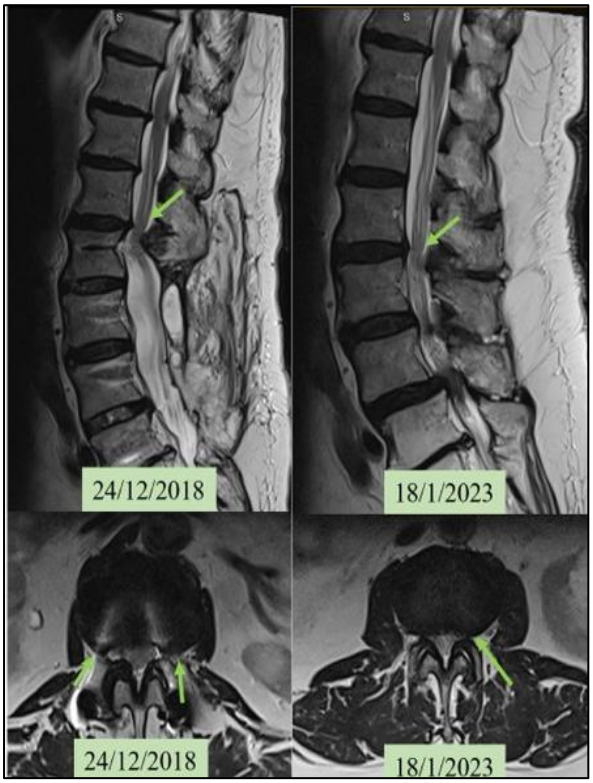

Figure 2: Pre-op and Post-op MRI images of a 76 years old male, post-posterior instrumentation of level (L2-S1) with decompression. Sagittal T2 and axial T2 images of the lumbar spine, showing interval development of diffuse disc bulge at L2-L3, and along with interval worsening of ligementum flavum thickening is resulting in mild to moderate central canal stenosis and right sided mild neural foraminal narrowing (not shown), on the post-operative images (2023) .

76 years old male, post-posterior instrumentation of level (L2-S1) with decompression.

Adjacent segment disease radiological progression

Cranial ASD output

Cranial ASD analysis indicated a significant association between age and ASD occurrence, with patients over 60 showing a higher incidence of worsening conditions compared to younger age groups (p=0.021). No other significant associations were found for other variables such as gender (p=0.732) and number of spinal segments fused (p=0.164) (Table 4).

Caudal ASD output

The caudal ASD analysis did not show any significant associations, similar to the cranial ASD output. Variables such as age (p=0.821), gender (p=0.084) and the number of spinal segments fused (p=0.235) did not significantly influence the ASD outcomes (Table 5).

Adjacent degenerative disease radiological progression.

Cranial ADD output.

The evaluation of cranial adjacent disc degeneration revealed no significant differences in terms of age, gender, number of spinal segments fused or the specific levels of fusion (all p values>0.05). The distribution of ADD changes did not significantly differ across categories within each variable, including age groups (p=0.596), gender (p=0.748) and number of spinal segments fused (p=1.0) (Table 6).

Caudal ADD output

Similarly, the caudal adjacent disc degeneration analysis mirrored the cranial findings with no significant differences in ADD changes across the demographic and surgical variables. Age groups (p=0.49), gender (p=0.485) and the number of spinal segments fused (p=0.691) showed no significant association with the worsening of disc conditions (Table 7).

Table 1: Patients survey pre-op and post-op.

Co-morbidities (diabetes mellitus, hypertension and scoliosis, spondylolisthesis)	Decreased function due to neurogenic claudication
Smoking history	Whether patients were undergoing any additional conservative treatments like physiotherapy, analgesic medications, epidural pain relief injections
Pain scale-VAS Scale (visual analog scale)	Whether or not they underwent revision surgery
Stiffness	
Persistence radicular pain without relief / Sciatica	

Table 2: Descriptive characteristics of the variables and demographic data.

Variable	Category	Frequency	
		Count	%
Age (in years)	<50	7	17
	50-60	5	37
	>60	9	46
Gender	Male	6	39
	Female	5	61
Number of spinal segments fused	1	2	29
	2	0	24
	3	8	44
	4	1	2
Levels of fusion	L2-L3	1	2
	L2-L5	13	32
	L2-S1	1	2
	L3-L4	4	10
	L3-L5	6	15
	L3-S1	5	12
	L4-L5	6	15
	L4-S1	4	10
	L5-S1	1	2
Level of spinal decompression/Laminectomy	L2-L3	1	2
	L2-L3, L3-L4	5	12
	L2-L3, L3-L4, L4-L5	6	15
	L3-L4	5	12
	L3-L4, L4-L5	9	22
	L3-L4, L4-L5, L5-S1	2	5
	L4-L5	7	17
	L4-L5, L5-S1	4	10
	L5-S1	2	5
Number of laminectomy levels	1	15	37
	2	18	44
	3	8	20
Discectomy	No	38	93
	Yes	3	7
DM	No	17	41
	Yes	24	59
HTN	No	14	34
	Yes	27	66
>2 comorbidities	No	17	41
	Yes	4	59
Scoliosis	No	4	83
	Yes	7	17
Spondylolisthesis	No	3	80
	Yes	8	20

Table 3: Incidence of adjacent segment disease (ASD) and adjacent disc degeneration (ADD).

Incidence	Total	%
ASD cranial	13	32
ASD caudal	15	37
ADD cranial	18	44
ADD caudal	12	29

Table 4: Cranial findings of adjacent segment disease.

Variable	Category	Cranial		P value Cranial+fishers exact test
		Aggregate unchanged	Aggregate worsened	
Age (in years)	<50	7	0	0.021
	50-60	12	3	
	>60	9	10	
Gender	Male	10	6	0.732
	Female	18	7	
Number of spinal segments fused	1	9	3	0.164
	2	4	6	
	3	14	4	
	4	1	0	
Levels of fusion	L2-L3	1	0	0.559
	L2-L5	10	3	
	L2-S1	1	0	
	L3-L4	2	2	
	L3-L5	2	4	
	L3-S1	4	1	
	L4-L5	5	1	
	L4-S1	2	2	
	L5-S1	1	0	
Level of adjacent disc	L1-L2	12	3	0.444
	L2-L3	8	7	
	L3-L4	7	3	
	L4-L5	1	0	
	L5-S1	N/A	N/A	
	S1-S2	N/A	N/A	
Level of spinal decompression/laminectomy	L2-L3	1	0	0.877
	L2-L3, L3-L4	4	1	
	L2-L3, L3-L4, L4-L5	4	2	
	L3-L4	3	2	
	L3-L4, L4-L5	4	5	
	L3-L4, L4-L5, L5-S1	2	0	
	L4-L5	5	2	
	L4-L5, L5-S1	3	1	
	L5-S1	2	0	
Number of laminectomy levels	1	11	4	0.749
	2	11	7	
	3	6	2	
Discectomy	No	26	12	1
	Yes	2	1	
DM	No	13	4	0.499
	Yes	15	9	
HTN	No	11	3	0.481
	Yes	17	10	
>2 comorbidities	No	13	4	0.499
	Yes	15	9	
Scoliosis	No	22	12	0.399
	Yes	6	1	
Spondylolisthesis	No	22	11	1
	Yes	6	2	

Table 5: Caudal findings of adjacent segment disease.

Variable	Category	Caudal		Pvalue Caudal+ fishers exact test
		Aggregate unchanged	Aggregate worsened	
Age (in years)	<50	5	3	0.821
	50-60	12	4	
	>60	14	8	
Gender	Male	11	8	0.084
	Female	20	7	
Number of spinal segments fused	1	6	7	0.235
	2	9	2	
	3	15	6	
	4	1	0	
Levels of fusion	L2-L3	1	0	0.103
	L2-L5	10	5	
	L2-S1	1	0	
	L3-L4	1	4	
	L3-L5	5	2	
	L3-S1	5	1	
	L4-L5	3	3	
	L4-S1	4	0	
	L5-S1	1	0	
Level of adjacent disc	L1-L2	N/A	0	0.748
	L2-L3	N/A	0	
	L3-L4	1	0	
	L4-L5	1	4	
	L5-S1	19	10	0.3
	S1-S2	10	1	
Level of spinal decompression/laminectomy	L2-L3	1	0	
	L2-L3, L3-L4	4	2	
	L2-L3, L3-L4, L4-L5	5	2	
	L3-L4	2	4	
	L3-L4, L4-L5	7	3	
	L3-L4, L4-L5, L5-S1	2	0	
	L4-L5	4	4	
	L4-L5, L5-S1	4	0	
	L5-S1	2	0	
Number of laminectomy levels	1	9	8	0.283
	2	15	5	
	3	7	2	
Discectomy	No	30	13	0.232
	Yes	1	2	
DM	No	13	7	0.742
	Yes	18	8	
HTN	No	10	7	0.307
	Yes	21	8	
>2 comorbidities	No	12	7	1
	Yes	19	8	
Scoliosis	No	25	13	0.399
	Yes	6	2	
Spondylolisthesis	No	25	13	1
	Yes	6	2	

Table 6: Cranial findings of adjacent disc degeneration.

Variable	Category	Cranial		P-value Cranial + fishers exact test
		Aggregate unchanged	Aggregate worsened	
Age (in years)	<50	5	2	0.596
	50-60	7	8	
	>60	11	8	
Gender	Male	8	8	0.748
	Female	15	10	
Number of spinal segments fused	1	7	5	1
	2	5	5	
	3	10	8	
	4	1	0	
Levels of fusion	L2-L3	0	1	0.903
	L2-L5	8	5	
	L2-S1	1	0	
	L3-L4	3	1	
	L3-L5	3	3	
	L3-S1	2	3	
	L4-L5	4	2	
	L4-S1	2	2	
	L5-S1	0	1	
Level of adjacent disc	L1-L2	9	6	0.877
	L2-L3	8	7	
	L3-L4	6	4	
	L4-L5	0	1	
	L5-S1	N/A	N/A	
	S1-S2	N/A	N/A	
Level of Spinal decompression/Laminectomy	L2-L3	0	1	0.941
	L2-L3, L3-L4	4	1	
	L2-L3, L3-L4, L4-L5	3	3	
	L3-L4	3	2	
	L3-L4, L4-L5	4	5	
	L3-L4, L4-L5, L5-S1	1	1	
	L4-L5	4	3	
	L4-L5, L5-S1	3	1	
	L5-S1	1	1	
Number of laminectomy levels	1	8	7	0.846
	2	11	7	
	3	4	4	
Discectomy	No	20	18	0.243
	Yes	3	0	
DM	No	9	8	0.76
	Yes	14	10	
HTN	No	9	5	0.52
	Yes	14	13	
>2 comorbidities	No	11	6	0.524
	Yes	12	12	
Scoliosis	No	21	13	0.209
	Yes	2	5	
Spondylolisthesis	No	19	14	0.713
	Yes	4	4	

Table 7: Caudal findings of adjacent disc degeneration.

Variable	Category	Caudal		P value Caudal+fishers exact test
		Aggregate unchanged	Aggregate worsened	
Age (in years)	<50	6	1	0.49
	50-60	9	6	
	>60	14	5	
Gender	Male	10	6	0.485
	Female	19	6	
Number of spinal segments fused	1	7	5	0.691
	2	8	2	
	3	13	5	
	4	1	0	
Levels of fusion	L2-L3	1	0	0.329
	L2-L5	8	5	
	L2-S1	1	0	
	L3-L4	1	3	
	L3-L5	4	2	
	L3-S1	5	0	
	L4-L5	4	2	
	L4-S1	4	0	
	L5-S1	1	0	
Level of Adjacent Disc	L1-L2	N/A	N/A	0.875
	L2-L3	0	0	
	L3-L4	1	0	
	L4-L5	1	3	
	L5-S1	17	9	
	S1-S2	10	0	
Level of Spinal decompression/Laminectomy	L2-L3	1	0	0.655
	L2-L3, L3-L4	3	2	
	L2-L3, L3-L4, L4-L5	4	2	
	L3-L4	2	3	
	L3-L4, L4-L5	7	2	
	L3-L4, L4-L5, L5-S1	2	0	
	L4-L5	4	3	
	L4-L5, L5-S1	4	0	
	L5-S1	2	0	
Number of laminectomy levels	1	9	6	0.555
	2	14	4	
	3	6	2	
Discectomy	No	27	11	1
	Yes	2	1	
DM	No	12	5	1
	Yes	17	7	
HTN	No	12	2	0.165
	Yes	17	10	
>2 comorbidities	No	11	6	0.507
	Yes	18	6	
Scoliosis	No	23	11	0.651
	Yes	6	1	
Spondylolisthesis	No	25	8	0.202
	Yes	4	4	

DISCUSSION

Posterior lumbar laminectomy and short-segment fusion are primary treatments for patients with degenerative spinal disorders that do not respond to conservative management.[1,7-11] These procedures aim to alleviate symptoms by stabilizing the spine and decompressing neural elements. However, adjacent segment disease (ASD) and adjacent disc degeneration (ADD) are significant complications following lumbar fusion, with studies showing a prevalence of radiographic-based ASD and symptomatic ASD at approximately 40% and between 5.2% and 18.5%, respectively.[1,5,12-33]

In this study, we utilized MRI to explore the relationship between pre-operative adjacent segment conditions and post-operative outcomes after a minimum average follow-up of six months. We evaluated ASD via visual findings and ADD using Pfirrmann's classification for intervertebral disc degeneration, while considering various reported risk factors.[3,5] The complex interplay of these risk factors is not fully understood; however, altered spinal biomechanics post-operation, such as increased intradiscal pressure and hypermobility at segments adjacent to fusion levels, are believed to be major contributors to further degeneration.[31,34]

The incidence of ASD varies, with one report indicating that radiographic ASD developed in 42.6% of patients and symptomatic ASD occurred in 30.3% of patients at a minimum of 5 years of follow-up.[10] Another study reported an incidence of 12.1% at a minimum follow-up of 4 years.[1] Our study found that 46% of patients experienced worsening of cranial ASD and 54% experienced worsening of caudal ASD at a minimum of 6 months post-operatively. Additionally, worsening ADD was observed in 60% for cranial and 40% for caudal segments according to the Pfirrmann classification post-operation.

While literature suggests lumbar ASD is more frequent at the cephalic level than at the distal level our results do not support this for ASD, but confirm it for ADD.[35] Significant increases in load on the posterior column at adjacent segments post-fusion have been observed and could be the cause of increased degeneration.[36] Furthermore, a meta-analysis indicated that a pre-op Pfirrmann classification above level 3 was associated with an increased incidence of ASD.[29] Despite having extensive research on the risk factors for developing ASD and ADD, we still cannot accurately predict this in our Bahraini population, which instigated our research. Hence, we noted each risk factors categorical effect on the degenerative findings of patients.

Advancing age has been identified by many studies as a major risk factor for an increase in ASD incidence.[15-22] Consistent with existing literature, our study found that advancing age was significantly associated with an increase in ASD. This underscores the importance of considering age as a primary factor when evaluating risks for postoperative complications. While other studies, such as those by (Park et al,) have suggested factors like gender and osteoporosis as significant, our findings did not corroborate this, particularly with gender showing no significant impact on ASD or ADD in our sample and we did not have the data to corroborate the effect of osteoporosis on our findings.[24]

There is debate over the impact of fusion length on ASD. Some studies suggest a significant risk with longer fusions, while others find little to no relationship (Wiltse et al and Soh et al.[14-24,27,32,37-42] Although we did not study long segment fusion, we did want to test the importance of the number of segments that are fused and our study did not identify any significant differences in worsening ASD or ADD in relation to increased number of segments fused and corroborates findings from (Wiltse et al and Soh et al).[27,32] Moreover, although some studies such as (Ghiselli et al,)found that patients who had a single-level fusion were more likely to have clinical ASD than those who had a multilevel fusion, this was not an observation that we noted within our study.[39]

High ASD incidence at decompressed sites than at non decompressed sites has been documented by (Ouchida et al,) yet our results did not show a significant relationship between laminectomy and decompression levels and worsening ASD or ADD post operation.[43] Existing, pre-operation disc degeneration was identified by (Bagheri et al,) as an independent risk factor for ASD, but our findings did not support this correlation.[1]

There are reported significant impacts of hypertension and diabetes on ASD incidence by (Wang et al,) however we did not find a statistically significant association between hypertension, diabetes or multiple comorbidities and worsening conditions for either ASD or ADD post operation.[29] Chou et al, identified that pathologies of the lumbar spine requiring fusion, such as adult scoliosis and spondylolisthesis, have been linked with adjacent segment pathologies.[2]

However, our data supports the findings of Wang et al, and identified no significant association between these conditions and worsening ASD or ADD.[29]

This study, while providing valuable insights, has several limitations. The design of the study being a retrospective study, it lacked the controls typically found in randomized trials. The relatively small sample size might also limit generalizability of the findings and the ability to detect the importance of less prominent risk factors and the inability to follow certain well documented risk factors like obesity and osteoporosis due to lack of information and bone mineral density scan also limits this study.

Future research should prioritize prospective studies or randomized trials with a larger sample size to further note the different risk factors effects on post-op patients that undergo short segment posterior instrumentations and their subsequent spinal degenerative changes. These studies

would help us understand further the management and prevention methods to reduce ASD and ADD Following lumbar fusion surgeries.

CONCLUSION

The findings from our study contribute to the understanding of ASD and ADD after lumbar fusion surgeries, particularly in highlighting the significance of age. These insights can aid surgeons in better anticipating the risks associated with specific demographic and clinical profiles. Future research should aim to explore these risk factors in larger, prospective or randomized controlled trials to validate and expand upon these findings, ensuring that surgical decisions are informed by robust, evidence-based data.

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